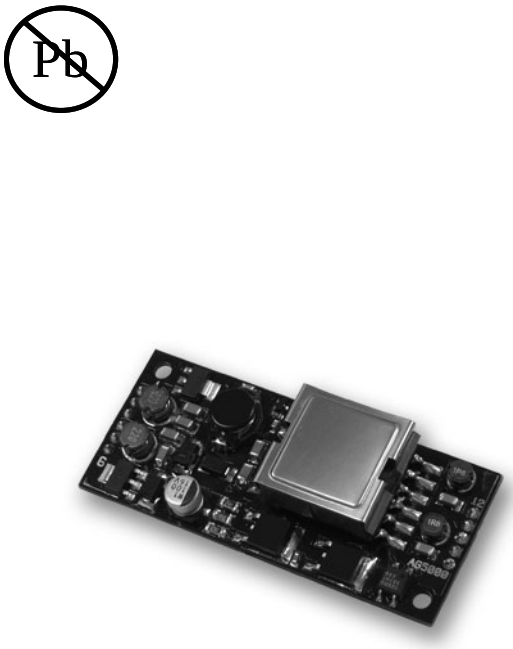
Silvertel

Ag5000

Power-Over-Ethernet Module



1 Features

- Maximum 30 Watt Output Power
- Dynamic input power sharing
- High efficiency DC/DC converter
- Wide adjustable output voltage range, to support trickle charge circuit
- 1500V isolation (input to output)
- Input voltage range 36V to 57V
- IEEE802.3af compliant inputs
- Low output ripple and noise
- Minimal (low cost) external components required
- Overload, thermal and short-circuit protection
- Silvertel “design-in” assistance

2 Description

The Ag5000 is a High Power over Ethernet (PoE+) module that can deliver up to 30 Watts of output power. Suitable for applications such as IP Telephones, WiMAX access points, PTZ cameras and thin client terminals.

The Ag5000 has been designed to extract power from Power Sourcing Equipment (PSE) over a conventional twisted pair Category 5 Ethernet cable. The modules dual inputs both conform to the IEEE 802.3af standard for signature recognition and class programming.

The Ag5000’s dynamic input power sharing, automatically detects if the input power is being supplied from the data pair, the spare pair or both pairs. The module can also detect voltage mismatches and adjust accordingly.

The high efficiency DC/DC converter operates over a wide input voltage range and provides a regulated low ripple and low noise output. The DC/DC converter also has built-in overload, thermal and short-circuit output protection.

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2.1 Table of Figures

3 Ag5000 Product Selector

Part Number†	Nominal Output Voltage ‡	Maximum Output Power *
Ag5000	12V / 24V	24W Continuous / 30W Peak

*At 25°C
† The Ag5000 fully meets the requirements of the RoHS directive 2002/95/EC on the restriction of hazardous substances in electronic equipment.
‡ Voltage depending on output configuration (Parallel or Series), see Section 5.7.

Table 1: Ordering Information

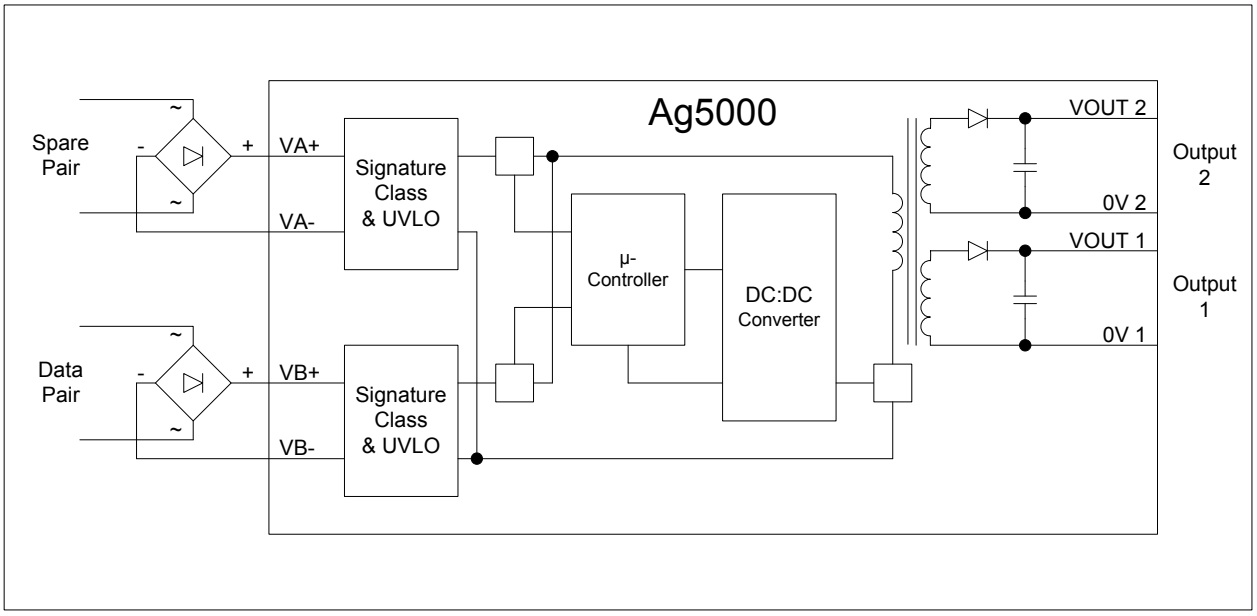

Figure 1: Block Diagram

Figure 2: Ag5000 DIL Package Format

4 Pin Description

Pin #	Name	Description
1	VA-	**Direct Input -**. This pin connects to the negative (-) output of the input bridge rectifier.
2	CPA	**Class Programming.** Connecting an external resistor from this pin to VA- will change the current class of this input. With no resistor fitted this input will default to Class 0.
3	VA+	**Direct Input +**. This pin connects to the positive (+) output of the input bridge rectifier.
4	VB+	**Direct Input +**. This pin connects to the positive (+) output of the input bridge rectifier.
5	CPB	**Class Programming.** Connecting an external resistor from this pin to VB- will change the current class of this input. With no resistor fitted this input will default to Class 0.
6	VB-	**Direct Input -**. This pin connects to the negative (-) output of the input bridge rectifier.
7	ADJ	**Output Adjust.** The output voltage can be adjusted from its nominal value, by connecting an external resistor from this pin to either the VOUT 1 pin or the 0V 1 pin.
8	0V 1	**Ground.** The ground return for the VOUT 1 output.
9	VOUT 1	**DC Output.** This pin provides the main regulated output from the DC/DC converter.
10	0V 2	**Ground.** The ground return for the VOUT 2 output.
11	VOUT 2	**DC Output.** This pin provides the secondary output from the DC/DC converter.

5 Functional Description

5.1 Inputs

The Ag5000 has two input pairs VA (+ & -) and VB (+ & -) as shown in Figure 3: Typical System Diagram, the on-board µ-controller automatically detects and monitors both of these inputs.

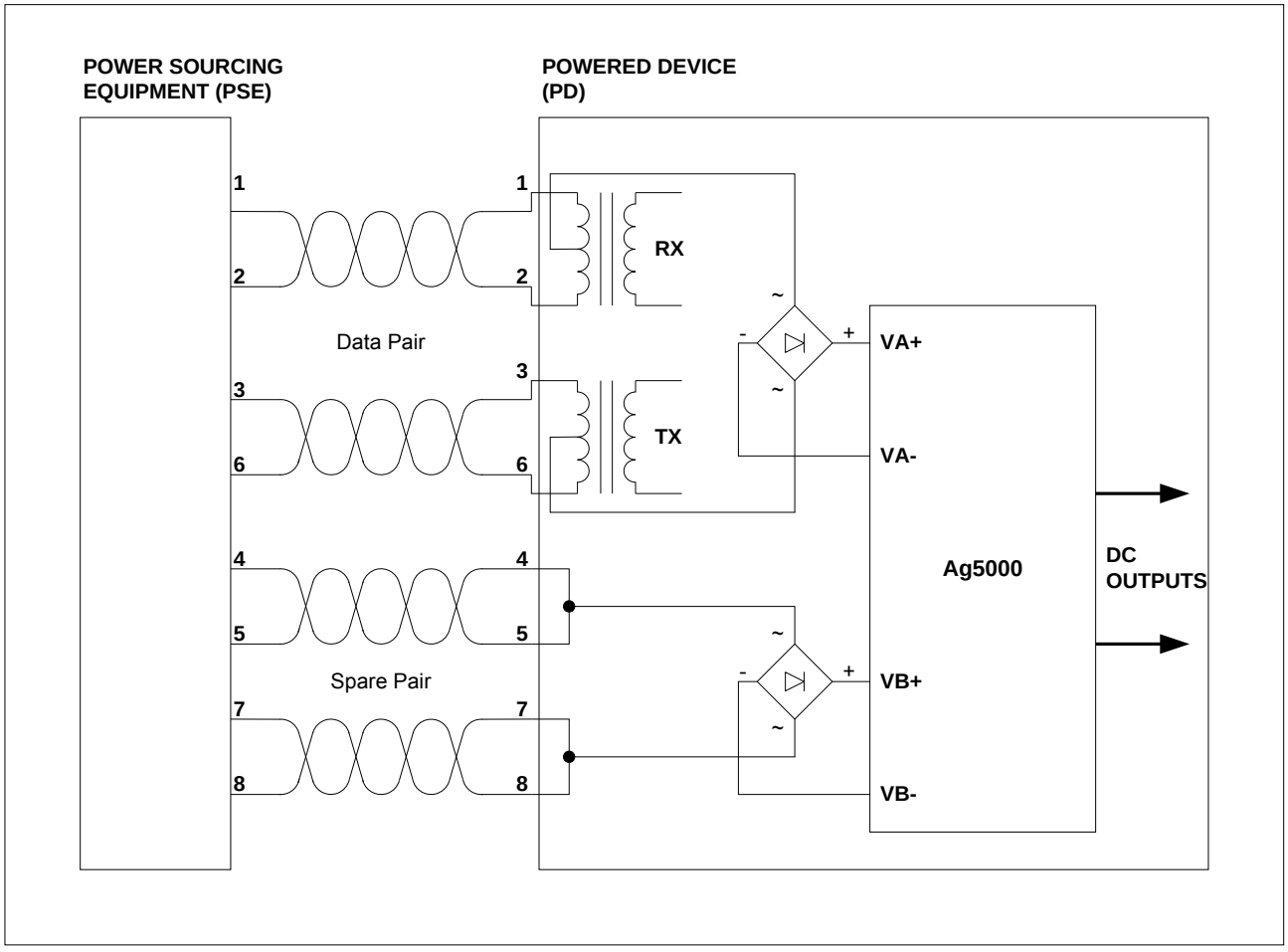

Figure 3: Typical System Diagram

5.2 PD Signature

Both inputs comply with the IEEE802.3af specification. When the inputs are connected to a Power Sourcing Equipment (PSE) via a Cat 5 cable, they will automatically present a Powered Device (PD) signature to the PSE (when requested). The equipment will then recognise that a PD is connected to that line and supply power.

Note: When using both inputs, the signature circuit will not work correctly if the PSE negative output rails are common. Multi-channel PSE's usually have a common positive output rail and switch the negative output rail, which is acceptable.

5.3 Isolation

To meet the safety isolation requirements of IEEE802.3af section 33.4.1 a Powered Device (PD) must pass the electrical strength test of IEC 60950 sub clause 6.2. This calls for either a) 1500VAC test or b) 1500V impulse test. The Ag5000 has been designed to meet b) 1500V impulse test. It is also important that the tracks on either side of the isolation barrier have at least a 3mm clearance, see Figures 10 for more information.

5.4 Power Classification

Both inputs offer IEEE802.3af “Class Programming”. This is optional from the PSE and is used for power management. The Ag5000 allows the current class to be externally programmed by connecting a resistor (RC1) between the CPA and VA- (or RC2 between CPB and VB-) pins, see Figure 4: Class Programming Option. If no resistor is fitted the Ag5000 will default to Class 0 which is recommended for high power applications. A full list of programming resistor values are shown in Table 2: Class Programming. For 24W operation, ensure that Class 0 is set (no resistor fitted).

CLASS	Programming Resistance (Ohms)	Min Power (W)	Max Power (W)
0	Do not fit		
1	698 ±1%	0.44	3.84
2	383 ±1%	3.84	6.49
3	249 ±1%	6.49	12.95
4	TBD	Reserved	Reserved

Table 2: Class Programming

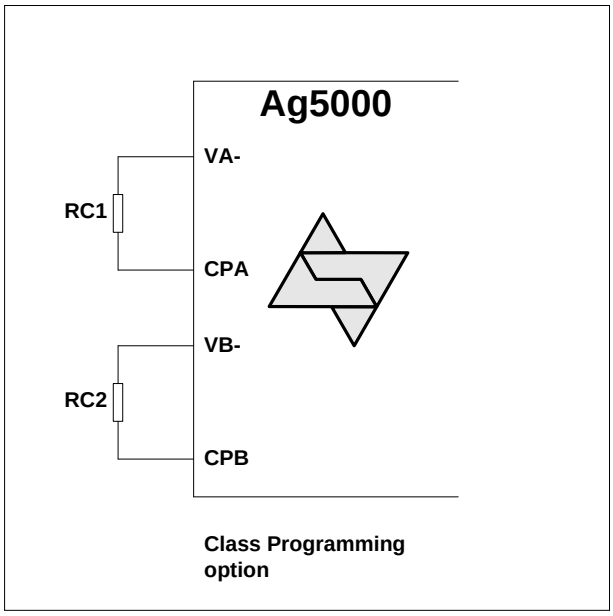

Figure 4: Class Programming Option

5.5 Dynamic Input Power Sharing

The Ag5000's dynamic input power sharing, automatically detects when power is available on either of its inputs, thus making it compatible with all the input configurations shown in Figure 5: Input Power Options.

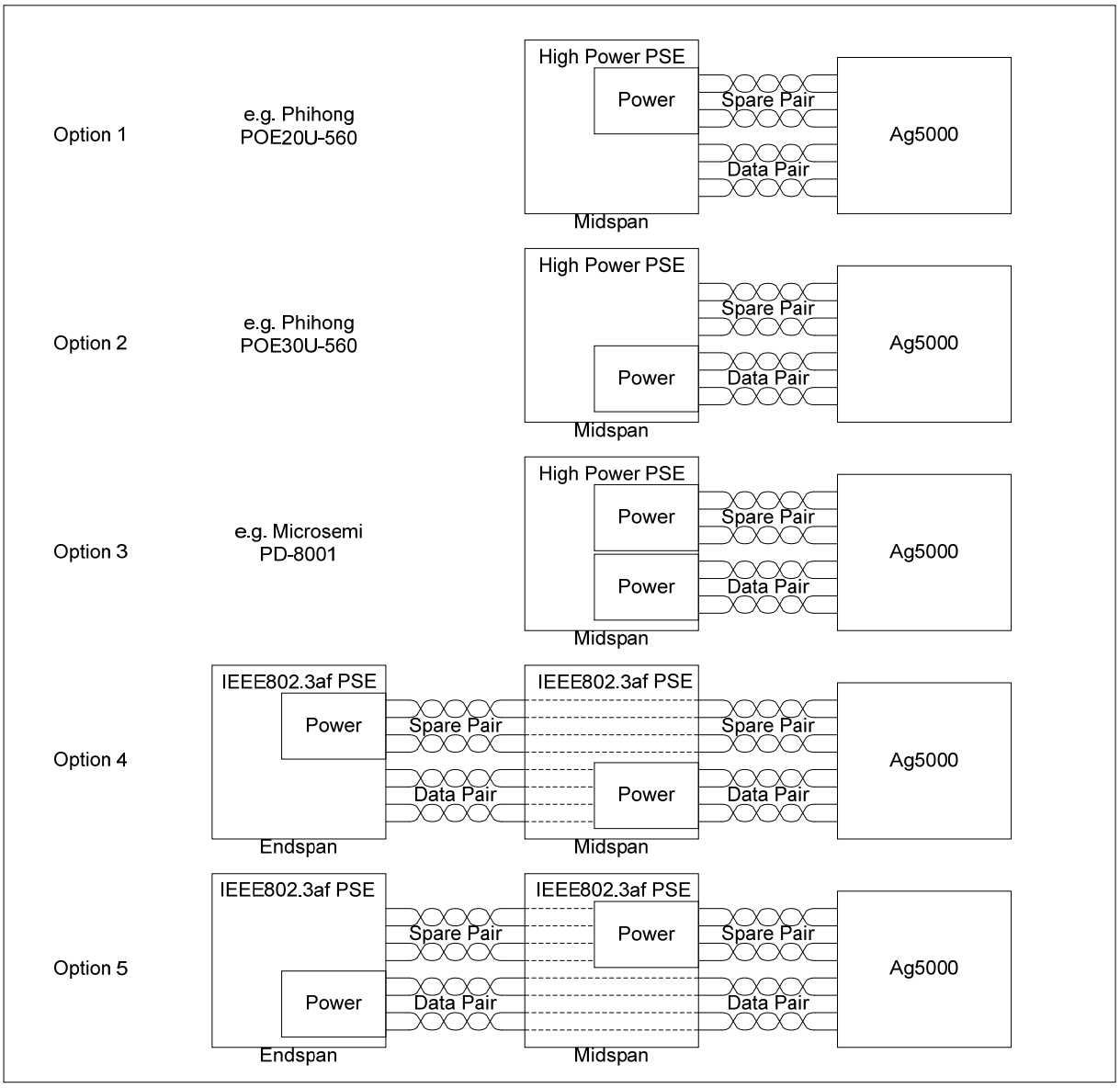

Figure 5: Input Power Options

In addition to automatically detecting the input power, when both inputs are used (Options 3, 4 and 5) the on-board µ–controller monitors the input voltage and will automatically compensate the input power sharing if the input voltages are different. This can occur if one of the pairs has a higher cable (or connector) resistance than the other; or with Options 4 and 5 the PSE output voltages may be different.

When used with two independent PSE's, it is important to note that the Ag5000 maximum output power will be limited by the PSE with the lower output current capability, as the inputs are current shared and not power shared.

5.6 DC/DC Converter

The Ag5000's DC/DC converter provides a regulated low ripple and low noise output that has built-in over-load and short-circuit output protection.

5.7 Output Configuration

The Ag5000 has two outputs which must be connected in parallel to provide 12V or in series to provide 24V, as shown in Figure 6: Output Configurations.

The output 2 voltage (VOUT 2) tracks the output 1 voltage (VOUT 1). The use of the two outputs separately is not recommended due to voltage regulation issues.

It is important that C1 and C2 are both used and connected as close to the output pins of the Ag5000 as possible (for both configurations). It is also important that C3 (100nF) is connected between VOUT 2 to 0V 1 (close to the pins) to reduce the level of output ripple and noise.

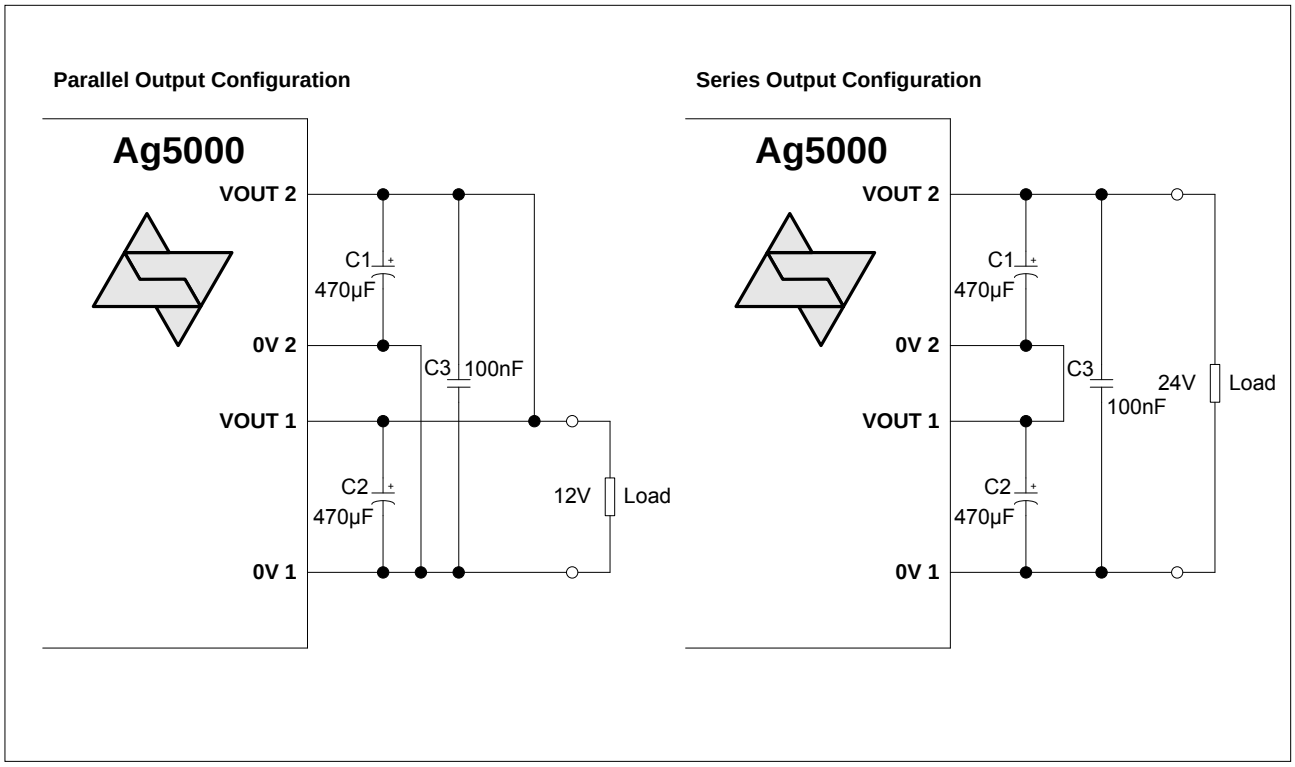

Figure 6: Output Configurations

It is also important that 0V 1 is connected to the system 0V (GND).

5.8 Output Adjustment

The Ag5000 has an ADJ pin, which allows the output voltage to be increased or decreased from its nominal value.

Figure 7: Output Adjustment shows how the ADJ pin is connected: -

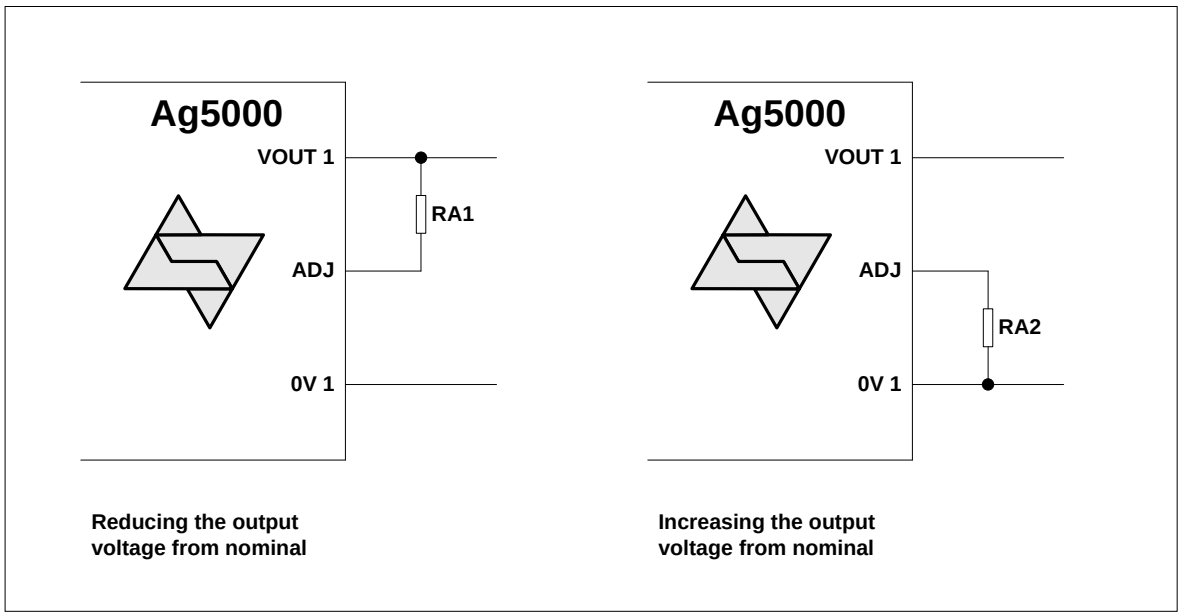

Figure 7: Output Adjustment

Reducing the output voltage, connect R between ADJ and VOUT 1		
Value of RA1	VOUT Parallel	VOUT Series
Open Circuit	12V	24V
30K	9V	18V
Increasing the output voltage, connect R between ADJ and 0V 1		
Value of RA2	VOUT Parallel	VOUT Series
Open Circuit	12V	24V
150K	12.5V	25V
0 Ohms	14.5V	29V

Table 3: Output Adjustment Resistor (R) Value

The adjustment range allows the Ag5000 to provide an output voltage from 9V up to 29V, contact Silvertel for further details.

5.9 Output Power

The maximum output power of the Ag5000 is 24W continuous / 30W peak; however this is limited by the available input power to the module.

When calculating the output power, the following factors must be taken into account: -

1. Ag5000 efficiency
2. PSE output power (current limit * see section Dynamic Input Power Sharing)
3. Cable and connector losses
4. Input bridge rectifier losses

5.10 Typical Connections

Figure 8: Typical Connection Diagram, a minimum of 470µF must be connected across each output, positioned as close to the output pins as possible. These capacitors are needed for step load change performance and can be a standard low cost electrolytic, they do not need to be a low ESR type.

The Class programming and the Output Adjust inputs are optional and are provided to give great flexibility to the Ag5000. Further information on using these inputs can be found in sections Power Classification and Output Adjustment.

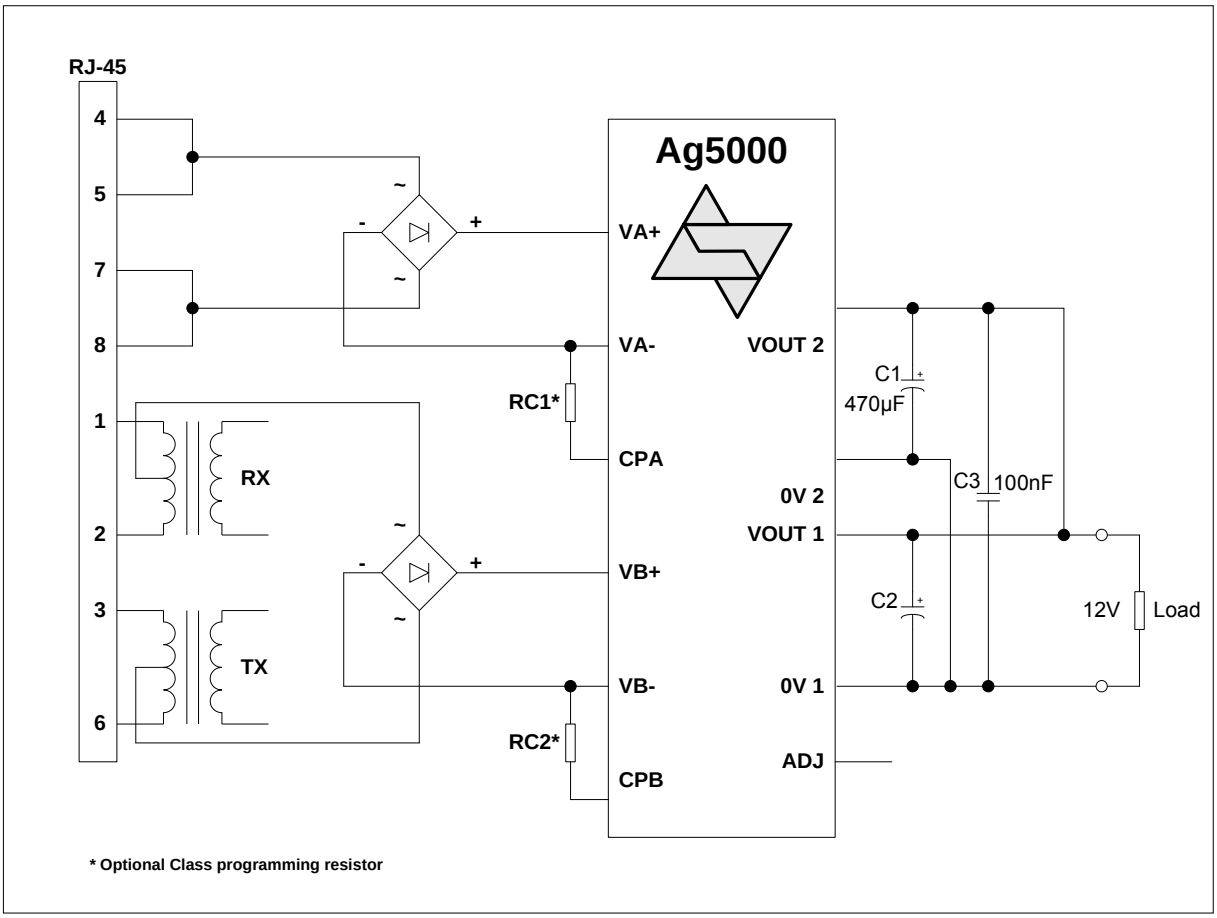

Figure 8: Typical Connection Diagram

6 Typical Application

The Ag5000 can be used in numerous applications, in the example shown in Figure 9: Typical Application, the data outputs from the Router are connected to the inputs of a Midspan. The Midspan will then add power (to the data from the Router) on each output that supports Power over Ethernet (PoE).

In this example port 1 is connected to an ethernet PTZ camera and port 2 is connected to a wireless access point, both of these devices have a built-in Ag5000. When the High Power Midspan is switched on (or when the device is connected), the Midspan will check each output for a PoE signature. On ports 1 and 2 the Ag5000 will identify themselves as PoE enabled devices and the Midspan will supply both data and power to these peripherals.

The other ports (shown in this example) will not have a PoE signature and the Midspan will only pass the data through to these peripherals. The Midspan will continuously monitor each output to see if a PoE enabled device has been added or removed.

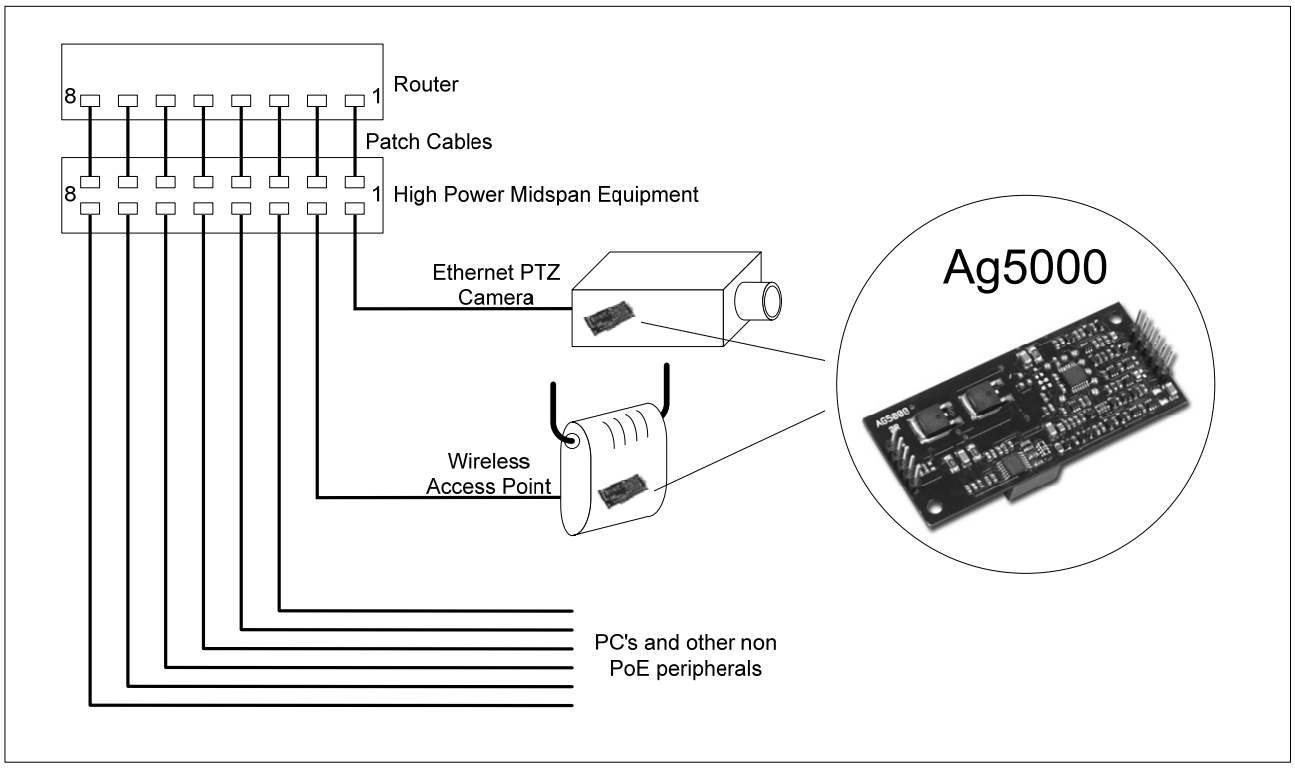

Figure 9: Typical Application

7 Typical Recommendations

Figure 10: Typical Layout gives an example of the tracking needed for the Ag5000. C1, C2 and C3 must be positioned as close to the output pins as possible.

RC1 and RC2 are only needed if IEEE802.3af Class Programming is required.

RA1 or RA2 can be fitted if output voltage adjustment is required.

To maintain the 1500V isolation barrier do not route track in the keep out area.

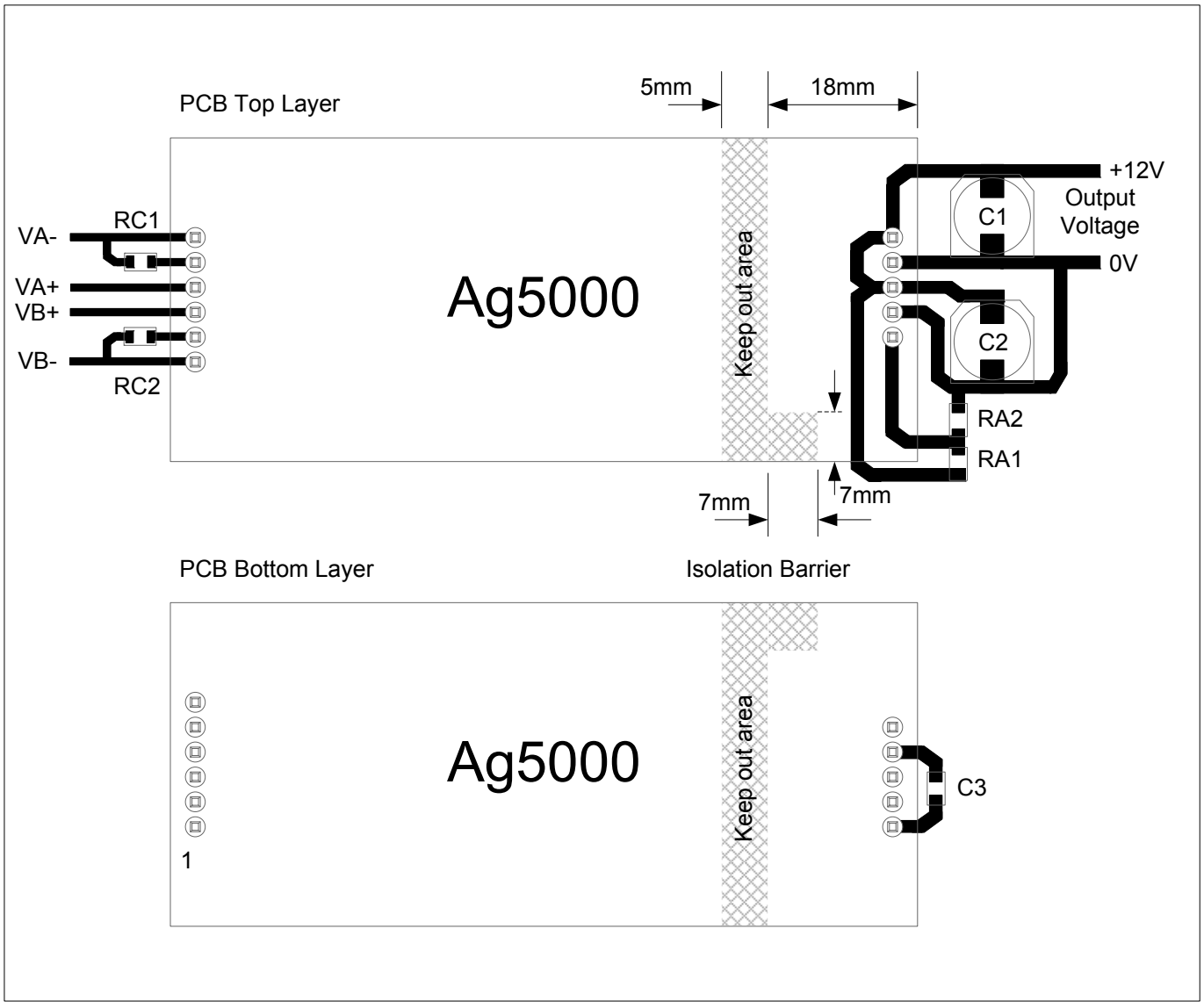

Figure 10: Typical Layout

8 Operating Temperature Range

Because the Ag5000 is a power component, it will generate heat, so it is important that this be taken into consideration at the design stage.

At the heart of the Ag5000 is a DC/DC converter, which like any other power supply will generate heat. The amount of heat generated by the module will depend on the load it is required to drive and the input voltage supplied by the PSE. The information shown within this section of datasheet is referenced to a single nominal 48Vdc input voltage supplied by the PSE.

The Ag5000 has a maximum ambient operating temperature of 70°C see Figure 11. These results are in still air without any heatsinking. The performance of the Ag5000 can be improved by forcing the airflow over the part or by using a heatsink (the Ag5000 has two heatsink mounting locations, as shown in Section 10.1).

The output stage of the Ag5000 has a built-in thermal protection circuit, to prevent the module from being damaged if operated beyond its power / temperature specification.

Because each application is different it is impossible to give fixed and absolute thermal recommendations. However it is important that any enclosure used has sufficient ventilation for the Ag5000 and a direct airflow if possible.

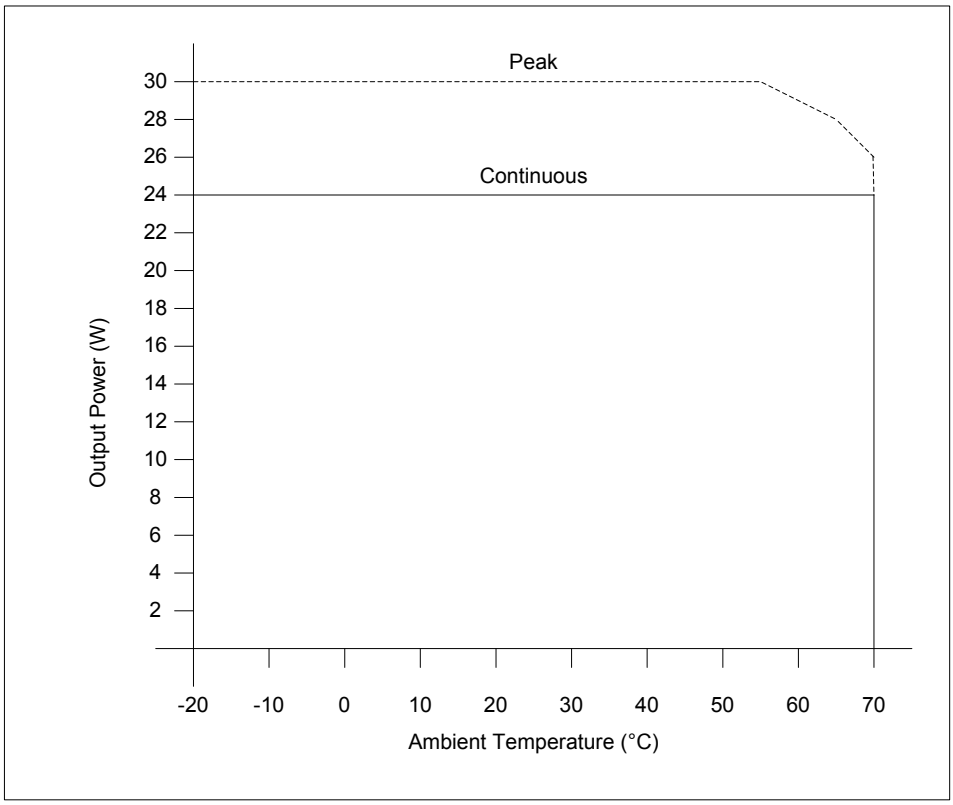

Figure 11: Ag5000 Operating Profile

9 Protection

The Ag5000 must be protected from over-voltages exceeding the 80V maximum rated surge input voltage. An inexpensive but effective solution can be achieved by connect Tranzorb diodes across each of the inputs; see Apps Note “ANX-POE-Protection”.

10 Electrical Characteristics

10.1 Absolute Maximum Ratings[1]

	Parameter	Symbol	Min	Max	Units
1	DC Supply Voltage	V_{CC}	-0.3	60	V
2	DC Supply Voltage Surge for 1ms	V_{SURGE}	-0.6	80	V
3	Storage Temperature	T_S	-40	+100	^{O}C

Note 1: Exceeding the above ratings may cause permanent damage to the product. Functional operation under these conditions is not implied. Maximum ratings assume free airflow.

10.2 Recommended Operating Conditions

	Parameter	Symbol	Min	Typ	Max	Units
1	Input Supply Voltage @ 24W Input Supply Voltage @ 30W	V_{IN}	36 44	48 51	57 57	V V
2	Under Voltage Lockout	V_{LOCK}	30		36	V
3	Operating Temperature [1]	T_{OP}	-20	25	70	Ta / ^{O}C

Note 1: See Section Operating Temperature Range

10.3 DC Electrical Characteristics

	10.3.1.1.1.1.1.1 DC Characteristic	Sym	Min	Typ [1]	Max	Units	Test Comments
1	Nominal Output Voltage	+VDC	11.4 22.8	12 24	12.6 25.2	V V	Parallel O/P Series O/P
2	Voltage Adjust Range	V_{ADJ}	8.5		29	V	See Output Adjustment
3	Continuous Output Current (V_{IN} = 48V)	I_{CONT}			2.0 1.0	A A	Parallel O/P Series O/P
4	Peak Output Current [2] (V_{IN} = 48V)	I_{PEAK}			2.5 1.25	A A	Parallel O/P Series O/P
5	Line Regulation	V_{LINE}		0.1		%	@ 50% Load
6	Load Regulation	V_{LOAD}		1.5		%	@ V_{IN}=48V
7	Output Ripple and Noise	V_{RN}		100		mVp-p	@ Max load [3]
8	Minimum Load	R_{LOAD}	250			mA	
9	Short-Circuit Duration	T_{SC}			∞	sec	
10	Efficiency	EFF		85		%	Vin = 48V 50% Load
11	Isolation Voltage (I/O)	V_{ISO}			1500	V_{PK}	Impulse Test

Note 1: Typical figures are at 25°C with a nominal 48V supply, parallel output configuration (unless otherwise stated) and are for design aid only. Not Guaranteed

2: The output must not exceed 30W or 2.5A Parallel / 1.25A Series.

3: The output ripple and noise can be reduced with an external filter, see application note.

11 Package

11.1 Ag5000